

THE CLAIMS:

The claims, as pending in the subject application, read as follows:

1. (Currently Amended) A method of reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising the steps of:

providing non-blue noise properties for each respective gray level of a dot pattern generated in a pixel block of a standard size using the mask of a size corresponding to a size smaller or substantially smaller than the standard size of the pixel block; and

generating, in the an output image[[,]] with no visually unpleasing artifacts moiré and/or certain repetitive pattern, when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

2. (Original) The method according to claim 1, wherein said output device has a resolution of about 600 dpi or greater.

3. (Cancelled)

4. (Original) The method according to claim 1, wherein said dot pattern generated by the mask has a value equal to or greater than 0.6 dB as an average value of anisotropy at each respective gray level.

5. (Original) The method according to claim 1, wherein adjacent masks are shifted along boundaries when said mask is repeatedly used and arranged two-dimensionally.

6. (Original) The method according to claim 1, wherein said mask is not a quadrilateral.

7. (Currently Amended) The method according to claim 1, wherein, as a process of determining a dot distribution at each respective gray level for producing said mask, a repulsive potential is assigned to all dots constructing a determined dot pattern of a specific gray levels and a new dot to determine a dot distribution for a next gray level is placed at a position having the lowest repulsive potential ~~[[in/]]~~ within the sum of said repulsive potentials.

8. (Currently Amended) A method of reproducing gray levels of a color image using the method according to any one of claims claim 1 to 7, wherein the input image is a color image, and wherein the color image is separated into a plurality of color components and at least one of the color components of the color image is used as the input image.

9. (Currently Amended) A method of reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising the steps of:

providing non-blue noise properties for each respective gray level of a dot pattern generated by the single mask; and

generating, in the an output image[[.]] with no visually unpleasing artifacts more and/or certain repetitive pattern when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

10. (Original) The method according to claim 9, wherein said output device has a resolution of about 600 dpi or greater.

11. (Cancelled)

12. (Original) The method according to claim 9, wherein adjacent masks are shifted along boundaries when said mask is repeatedly used and arranged two-dimensionally.

13. (Original) The method according to claim 9, wherein said mask is not a quadrilateral.

14. (Currently Amended) The method according to claim 9, wherein, as a process of determining a dot distribution at each respective gray level for producing said mask, a repulsive potential is assigned to all dots constructing a determined dot pattern of a specific gray level and a new dot to determine a dot distribution for a next gray level is placed at a position having the lowest repulsive potential [[in/]]within the sum of said repulsive potentials.

15. (Currently Amended) A method of reproducing gray levels of a color image using the method according to any one of claims claim 9 to 14, wherein the input image is a color image, and wherein the color image is separated into a plurality of color components and at least one of the color components of the color image is used as the input image.

16. (Currently Amended) A method of reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising the steps of:

providing a plurality of isolated spectra for a two-dimensional-spatial frequency spectrum of an individual dot pattern generated by a single mask at each respective gray level; and

generating, in the an output image[,], with no visually displeasing artifacts moiré and/or certain repetitive pattern when the input image undergoes the a gray level reproducing process and the produced image is output[[ted]] by an output device.

17. (Original) The method according to claim 16, wherein each dot pattern generated by said mask has a noise component having small low frequency components of a one-dimensional power spectrum due to weak irregularity (perturbation) or pseudo-periodicity introduced at a plurality of gray levels.

18. (Original) The method according to claim 16, wherein said output device has a resolution of about 600 dpi or greater.

19. (Canceled)

20. (Original) The method according to claim 16, wherein adjacent masks are shifted along boundaries when said mask is repeatedly used and arranged two-dimensionally.

21. (Original) The method according to claim 16, wherein said mask is not a quadrilateral.

22. (Original) The method according to claim 16, wherein, as a process of determining a dot distribution at each respective gray level for producing said mask, a repulsive potential is assigned to all dots constructing a determined dot pattern of a specific gray level and a new dot to determine a dot distribution for a next gray level is placed at a position having the lowest repulsive potential in/within the sum of said repulsive potentials.

23. (Currently Amended) A method of ~~reproducing gray levels of a color image using the method~~ according to ~~any one of claims~~ claim 16 to 22, wherein the input image is a color image, and wherein the color image is separated into a plurality of color components and at least one of the color components of the color image is used as the input image.

24. (Currently Amended) A method of representing the density of each pixel of an output image by binary or multivalued data based on a one-to-one

correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising the steps of:

~~composing~~ said mask ~~to have a~~ ~~having~~ the size of an array of a plurality of element masks, each of which ~~being of the~~ ~~are a~~ same size as that of a mask used in the a dispersed-dot dithering method; and

~~generating~~ a dot pattern ~~generated by said mask, the dot pattern comprising:~~

(1) ~~having~~ at least a set of element pixel blocks, each of which ~~corresponding~~ ~~corresponds~~ to each element mask and ~~having~~ ~~has~~ the same dot distribution at each respective gray level;

(2) ~~having~~ weak irregularity (perturbation) or pseudoperiodicity introduced at a certain gray level;

(3) ~~having~~ an equal number of dots in every element pixel block at each respective gray level; and

(4) ~~having~~ an equal number of dots in four individual partial element pixel blocks each having a quarter size of an element pixel block at each respective (4n)th (n indicates a positive integer) gray level.

25. (Currently Amended) The method according to claim 24, wherein said weak irregularity (perturbation) or pseudo-periodicity is introduced at a certain low gray level equal to or higher than the a first gray level.

26. (Currently Amended) The method according to claim 24, wherein the size of said mask is smaller ~~or substantially smaller~~ than the a size corresponding to a

standard size pixel block and the mask is repeatedly arranged two-dimensionally and regularly corresponding to the entire input image.

27. (Canceled)

28. (Currently Amended) The method according to claim 24, wherein said dot pattern generated in the output image has no ~~visually unpleasing artifacts~~ moiré and/or certain repetitive pattern, when the input image undergoes said gray level reproducing process and the produced image is output[[ted]] by an output device.

29. (Original) The method according to claim 28, wherein said output device has a resolution of about 600 dpi or greater.

30. (Canceled)

31. (Original) The method according to claim 24, wherein adjacent masks are shifted along boundaries when said mask is repeatedly used and arranged two-dimensionally.

32. (Original) The method according to claim 24, wherein said mask is not a quadrilateral.

33. (Original) The method according to claim 24, wherein said weak irregularity (perturbation) or pseudo-periodicity is implemented by providing small pixel

blocks, each having a number of pixels equal to or smaller than a quarter ($1/4$) of the total number of pixels in an element pixel block, at predetermined positions in all or a part of the individual element pixel blocks, each corresponding to each element mask, and by selecting one pixel for a dot in each of said small pixel blocks.

34. (Currently Amended) The method according to claim 24, wherein, as a process of determining a dot distribution at each respective gray level for producing said mask, a repulsive potential is assigned to all dots constructing a determined dot pattern of a specific gray level and a new dot to determine a dot distribution for a next gray level is placed at a position having the lowest repulsive potential $[[in/]]$ within the sum of said repulsive potentials.

35. (Currently Amended) ~~A method of reproducing gray levels of a color image using the method according to any one of claims claim 24 to 34, wherein the input image is a color image, and wherein the color image is separated into a plurality of color components; and at least one of the color components of the color image is used as the input image.~~

36. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), wherein comprising:

storage means for storing the mask;

comparison means for comparing each value of the mask with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means,

wherein the mask provides providing non-blue noise properties for each respective gray level of a dot pattern generated in a pixel block of a standard size using the a mask of a size smaller ~~or substantially smaller~~ than the standard size of the pixel block; and

wherein the binary or multivalued dot pattern is generated generating, in the output image[[,]] such that no visually unpleasing artifacts moiré and/or certain repetitive pattern is generated[[,]] when the input image undergoes the a gray level reproducing process and the image is output by an output device.

37. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), wherein comprising:

storage means for storing the mask;

comparison means for comparing each value of the mask with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means,

wherein the mask provides providing non-blue noise properties for each respective gray level of a dot pattern generated by the a single mask; and

wherein the binary or multivalued dot pattern is generated generating, in the output image[,] such that no visually unpleasing artifacts moiré and/or certain repetitive pattern is generated when an input image undergoes a gray level reproducing process and the produced image is output by an output device.

38. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), wherein comprising:

storage means for storing the mask;

comparison means for comparing each value of the mask with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means,

wherein the mask provides providing a plurality of isolated spectra for a two-dimensional spatial frequency spectrum of a dot pattern generated by the a single mask at each respective gray level; and

wherein the binary or multivalued dot pattern is generated generating, in an output image[,] such that no visually unpleasing artifacts moiré and/or certain repetitive pattern is generated when the input image has undergone a gray level reproducing process and is output by an output device.

39. (Currently Amended) An apparatus for representing the density of each pixel of an output image by binary or multivalued data based on a one-to-one

correspondence of each pixel of an input image to each element of a threshold matrix (a mask), wherein comprising:

storage means for storing the mask;

comparison means for comparing each value of the mask with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means.

composing wherein said mask is composed by an array of a plurality of element masks, each of which ~~being of the~~ has a same size as that of a mask used in the a dispersed-dot dithering method; and

wherein said mask generates ~~generating, by said mask,~~ a dot pattern:

(1) having at least a set of element pixel blocks, each of which ~~corresponding~~ corresponds to each element mask and having the a same dot distribution at each respective gray level;

(2) having weak irregularity (perturbation) or pseudo-periodicity introduced at a certain gray level;

(3) having an equal number of dots in every element pixel block at each respective gray level; and

(4) having an equal number of dots in four individual partial element pixel blocks each having a quarter (1/4) size of an element pixel block at each respective (4n)th (n indicates a positive integer) gray level.

40. (Currently Amended) The apparatus according to claim 39, wherein said weak irregularity (perturbation) or pseudo-periodicity is introduced at a certain low gray level equal to or higher than the a first gray level.

41. (Currently Amended) The apparatus according to claim 39, wherein the size of said mask is smaller ~~or substantially smaller~~ than the size corresponding to a standard size of a pixel block and repeatedly arranged two-dimensionally and regularly corresponding to the entire input image.

42. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

storage means for storing the threshold matrix;

comparison means for comparing each value of the threshold matrix with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means, wherein:

said threshold matrix has a size corresponding to a size smaller or ~~substantially smaller~~ than a standard size pixel block, a dot pattern generated in the standard size pixel block has non-blue noise properties at each respective gray level, and ~~visually unpleasant artifacts~~ moiré and/or certain repetitive pattern are not generated in the output image when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

43. (Original) The apparatus according to claim 42, wherein said output device has a resolution of about 600 dpi or greater.

44. (Canceled)

45. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

storage means for storing the threshold matrix;

comparison means for comparing each value of the threshold matrix with a density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means, wherein:

said threshold matrix produces, by-itself, the a dot pattern having non-blue noise properties at each respective gray level, and generates, in the an output image[[,]] with no visually unpleasing artifacts moiré and/or certain repetitive pattern when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

46. (Original) The apparatus according to claim 45, wherein said output device has a resolution of about 600 dpi or greater.

47. (Canceled)

48. (Original) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

storage means for storing the threshold matrix;

comparison means for comparing each value of the threshold matrix with density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means, wherein:

said threshold matrix produces, by itself, a dot pattern having a plurality of isolated spectra in a two-dimensional spatial frequency spectrum at each respective gray level and assigns a noise component having small low frequency components to a one-dimensional power spectrum of a dot distribution at a plurality of gray levels.

49. (Original) The apparatus according to claim 48, wherein said threshold matrix assigns said noise component by introducing weak irregularity (perturbation) or pseudo-periodicity in the dot distribution at said plurality of gray levels.

50. (Currently Amended) An apparatus for reproducing gray levels to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

storage means for storing the threshold matrix;

comparison means for comparing each value of the threshold matrix with the density of each pixel of the input image; and

output means for outputting a binary or multivalued dot pattern based on comparison results of said comparison means, wherein:

said mask has the a size of an array of a plurality of element masks, each of which ~~being of the~~ is a same size as that of a mask used in the a dispersed-dot dithering method, and generates a dot pattern:

(1) having at least a set of element pixel blocks, each of which corresponding corresponds to each element mask and having the same dot distribution at each respective gray level;

(2) having weak irregularity (perturbation) or pseudoperiodicity introduced at a certain gray level;

(3) having an equal number of dots in every element pixel block at each respective gray level; and

(4) having an equal number of dots in four individual partial element pixel blocks each having a quarter (1/4) size of an element pixel block at each respective (4n)th (n indicates a positive integer) gray level.

51. (Currently Amended) The apparatus according to claim 50, wherein said weak irregularity (perturbation) or pseudo-periodicity is introduced at a certain low gray level equal to or higher than the a first gray level.

52. (Currently Amended) A threshold matrix (a mask) for use in converting the density of each pixel of an input image into binary or multivalued data,

wherein said threshold matrix has a size corresponding to a size smaller or substantially smaller than a standard size of a pixel block, wherein a dot pattern generated by said threshold matrix in the standard size pixel block has non-blue noise properties at each respective gray level, and ~~visually unpleasing artifacts~~ moiré and/or a certain repetitive pattern are not generated in an output image when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

53. (Original) The threshold matrix according to claim 52, wherein said output device has a resolution of about 600 dpi or greater.

54. (Canceled)

55. (Currently Amended) A threshold matrix (a mask) for use in converting the density of each pixel of an input image into binary or multivalued data, wherein said threshold matrix produces, by itself, a dot pattern having non-blue noise properties at each respective gray level, and generates in an output image[,] with no visually unpleasing artifacts moiré and/or certain repetitive pattern when the input image undergoes the a gray level reproducing process and the produced image is output by an output device.

56. (Original) The threshold matrix according to claim 55, wherein said output device has a resolution of about 600 dpi or greater.

57. (Canceled)

58. (Currently Amended) A threshold matrix (a mask) for use in converting the density of each pixel of an input image into binary or multivalued data, wherein said threshold matrix produces, by itself, a dot pattern having a plurality of isolated spectra in a two-dimensional spatial frequency spectrum at each respective gray level and assigns a noise component having small low frequency components to a one-dimensional power spectrum of the a dot distribution at a plurality of gray levels.

59. (Original) The threshold matrix according to claim 58, wherein said threshold matrix assigns said noise component by introducing weak irregularity (perturbation) or pseudo-periodicity in the dot distribution at said plurality of gray levels.

60. (Currently Amended) A threshold matrix (a mask) for use in converting the density of each pixel of an input image into binary or multivalued data, wherein said mask ~~having the~~ has a size of an array of a plurality of element masks, each of which ~~being of the~~ is a same size as that of a mask used in the a dispersed-dot dithering method, and a generated dot pattern has:

(1) at least a set of element pixel blocks, each of which ~~corresponding~~ corresponds to each element mask and having the same dot distribution at each respective gray level;

(2) weak irregularity (perturbation) or pseudoperiodicity introduced at a certain gray level;

(3) an equal number of dots in every element pixel block at each respective gray level; and

(4) an equal number of dots in four individual partial element pixel blocks each having a quarter ($1/4$) size of an element pixel block at each respective $(4n)$ th (n indicates a positive integer) gray level.

61. (Currently Amended) The threshold matrix according to claim 60, wherein said weak irregularity (perturbation) or pseudo-periodicity is introduced at a certain low gray level equal to or higher than the a first gray level.

62. (Currently Amended) A computer-readable storage medium storing a control program for controlling a gray level reproducing process to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results,

wherein, the [[a]] threshold matrix having has a size corresponding to a size smaller or substantially smaller than a standard size of a pixel block, wherein a dot pattern generated, by the threshold matrix, in a pixel block of the standard size having has non-blue noise properties at each respective gray level, and wherein visually-unpleasing artifacts moiré and/or a certain repetitive pattern are not generated in the output image when the input image undergoes the a gray level reproducing process and the produced image is output by an output device, and

~~a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results.~~

63. (Original) The computer-readable storage medium according to claim 62, wherein said output device has a resolution of about 600 dpi or greater.

64. (Canceled)

65. (Currently Amended) A computer-readable storage medium storing a control program for controlling a gray level reproducing process to represent density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results.

wherein the [[a]] threshold matrix for producing produces, by itself, a dot pattern having non-blue noise properties at each respective gray level, and wherein visually unpleasing artifacts moiré and/or a certain repetitive pattern are not generated when the input image undergoes the a gray level reproducing process and the produced image is output[[ted]] by an output device;and

~~a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results.~~

66. (Original) The computer-readable storage medium according to claim 65, wherein said output device has a resolution of about 600 dpi or greater.

67. (Canceled)

68. (Currently Amended) A computer-readable storage medium storing a control program for controlling a gray level reproducing process to represent the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results,

wherein the threshold matrix producing produces, by itself, a dot pattern having a plurality of isolated spectra in a two-dimensional spatial frequency spectrum at each respective gray level and assigning assigns a noise component having a small low frequency component to a one-dimensional power spectrum of a dot distribution at each of a plurality of gray levels; and

~~a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results.~~

69. (Original) The computer-readable storage medium according to claim 68, wherein said noise component is caused by introducing weak irregularity (perturbation) or pseudo-periodicity in the dot distribution at said plurality of gray levels.

70. (Currently Amended) A computer-readable storage medium storing a control program for controlling a gray level reproducing process to reproduce the density of each pixel of an output image by binary or multivalued data based on a one-to-one correspondence of each pixel of an input image to each element of a threshold matrix (a mask), comprising:

a module for comparing each value of the threshold matrix with the density of each pixel of the input image, and for controlling an output of each binary or multivalued dot pattern depending on the comparison results,

wherein the threshold matrix having the has a size of an array of a plurality of element masks, each of which being of the is a same size as that of a mask used in the a dispersed-dot dithering method, wherein a generated dot pattern has:

(1) at least a set of element pixel blocks each of which ~~corresponding~~ corresponds to each element mask and ~~having the has a~~ same dot distribution at each respective gray level;

(2) weak irregularity (perturbation) or pseudoperiodicity introduced at a certain gray level;

(3) an equal number of dots in every element pixel block at each respective gray level; and

(4) an equal number of dots in four individual partial element pixel blocks each having a quarter ($1/4$) size of each element pixel block at each respective $(4n)$ th (n indicates a positive integer) gray level; and

~~a module for comparing each value of the threshold matrix with density of each pixel of the input image, and for controlling an output of each binary or multivalue dot pattern depending on the comparison results.~~

71. (Currently Amended) The computer-readable storage medium according to claim 70, wherein said weak irregularity (perturbation) or pseudo-periodicity is introduced at a certain low gray level equal to or higher than ~~the~~ a first gray level.

72. to 74. (Canceled)